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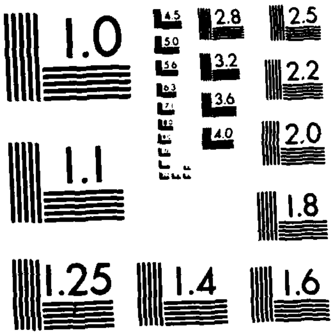

DETERMINING THE BOEING 747 CONVERSION COSTS FOR THE CIVIL RESERVE AIR FLEET ENHANCEMENT PROGRAM

James C. Orr, Captain, USAF

LSSR 39-83

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

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The Civil Reserve Air Fleet (CRAF) Enhancement Program provides a contractual arrangement between the Air Force and major U.S. airlines for modifying Boeing 747 and DC-10 passenger aircraft for use as convertibles--aircraft capable of carrying military cargo in an emergency, while providing commercial passenger service in peacetime. The airlines will incur several costs as a result of modifying these aircraft, each of which must be reimbursed by the Air Force. The costs incurred by the airlines include: net revenue lsot during the eight week modification period; the modification cost; increased operating costs for 16 years due to the higher weight and increased value of a convertible aircraft; and the opportunity cost of retaining a modified aircraft for 16 years. Each of these costs were calculated for the Boeing 747, with the following results: $3,014,564 net loss of revenue during modification; $14,300,000 modification cost; $6,637,015 increased operating costs for 16 years; and no opportunity cost. These costs total $23,951,579, and represent the amount of reimbursement from the Air Force for each Boeing 747 conversion.

LSSR 38-83

DETERMINING THE BOEING 747 CONVERSION COSTS FOR THE CIVIL RESERVE AIR FLEET ENHANCMENT PROGRAM

A Thesis

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirement for

Degree of Master of Science in Logistics Management

BY

James C. Orr
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CHAPTER I

INTRODUCTION

As a result of Soviet expansionism and America's increasing reliance upon imported resources, the Department of Defense is placing greater emphasis on the ability to rapidly project military forces throughout the world. Our airlift resources are considered inadequate, however, and means are being sought to increase our airlift capability. One proposal, the Civil Reserve Air Fleet Enhancement Plan, would have the Department of Defense contract various airlines to modify wide-bodied passenger aircraft for use as convertibles--aircraft capable of carrying military cargo in an emergency, while providing commercial passenger service in peacetime.

Soviet Expansionism

The Soviets are expanding their world influence by increasing their military capability and using this capability to extend their presence in numerous third world countries.

In the past two decades, the Soviets have greatly expanded their military power from what was previously a continental and largely defensive land army to a global,

offensive army, navy, and air force. During this period their expenditures on defense have far exceeded those of the United States. According to the Department of Defense, twelve to fourteen percent of the Soviet's Gross National Product has been spent on defense compared to approximately six percent for the United States (30:74). In the past ten years the Soviets have outspent the United States in defense by more than $400 billion (21:15), tripling their spending over the United States on nuclear armaments and doubling their spending on conventional armaments (54:46). Their fighter aircraft production rate has exceeded ours by a factor of three to one; tanks, four to one; and ships (surface and submarine), three to one (21:151). This increased arms buildup has not only improved the Soviet's military posture, but has also led to an extension of their political and military influence among third world nations.

In recent years the Soviets have established their presence in Afghanistan, Angola, Cambodia, and, most recently, Central America. Secretary of the Air Force Verne Orr (30:74) relates Soviet expansionism directly to their increased military capability:

> This new military muscle of the Soviet Union has altered both the reality and the perception of the global military balance, and given the Kremlin increasing confidence to undertake military options previously considered too risky.

Soviet expansion is a threat to the United States because our

security interests are linked to other regimes of the world on a greater scale than ever before. Third world or developing nations flank 23 of the 31 essential United States foreign trade routes, upon which the economic life-blood of the United States and Europe depends (30:74).

This Soviet adventurism and military buildup is a cause for the United States to increase its ability to project forces throughout the world on a timely basis.

Resource Dependency

The second reason for enhancing our force projection capability is that the same third world nations being threatened by Soviet expansion are the principal sources of energy resources and raw materials critical to the economy and defense of the free world. During the past decade our nation has become increasingly dependent on foreign resources for oil and other critical raw materials. Though we were exporters of oil until the 1950s, we now import approximately 50% percent of our total oil requirements; and the problem is more acute for NATO and Japan (30:74). Of equal concern is our reliance upon critical minerals. The United States must import more than 90% of nine of the most critical commodities. And 22 of the 74 non-energy mineral commodities essential to the United State's economy must be imported (30:74). Table 1.1 shows the import reliance of six selected non-energy minerals.

Table 1.1

U.S. Import Reliance on Nonfuel Minerals			
Nonfuel Mineral	Import Reliance	Uses	Principal Sources
Chromium	90%	Stainless Steel	Republic of South Africa, Philippines, U.S.S.R., Turkey, Southern Rhodesia, Japan
Cobalt	90%	Magnets	Zaire, Belgium, Luxembourg, Zambia, Finland
Manganese	98%	Armor plating	Brazil, Australia, Republic of South Africa, France, Japan
Nickel	77%	Stainless steel	Canada, Norway, Dominican Republic
Tin	81%	Ball bearings	Malaysia, Thailand, Indonesia, Bolivia
Tungsten	59%	High speed tools	Canada, Bolivia, Republic of Korea

Source: "Mineral Commodity Summaries, 1980," Bureau of Mines

The significance of our dependency on these critical minerals can be illustrated by examining our use of cobalt. The Pratt and Whitney F-100 engine used in the F-15 and F-16 aircraft requires 910 pounds of cobalt. 42% of this mineral comes from the African nation of Zaire. During the May 1978 civil war in Zaire, the critical supply of cobalt to the United States was disrupted with a resultant price rise from $6 to $25 per pound, increasing the price of F-100 engines

by $18,000. Further, it is estimated that if the supply of cobalt had been cut off and we had depleted our reserves, a significant proportion of the U.S. commercial aircraft fleet would have been grounded after a single year as a result of a major shortfall in engine spare parts (30:74). Modern technology makes us dependent on these materials for future survival; yet political realities make their availability uncertain.

Geographic realities also make resource availability uncertain; the United States is significantly farther away from important resources than is the Soviet Union. Table 1.2 indicates the degree of geographic asymmetry vis-a-vis the Soviet Union, as estimated by Colonel Alan L. Gropman, USAF, Director of Research and Associate Dean of the National War College:

Table 1.2 (15:5)

Resources Closer to the U.S.S.R. than to the U.S.	
Resources	Percent Closer to the U.S.S.R.
land (less Antarctica)	62
population	81
gross national product	65
proven oil reserves	86
natural	81

This geostrategic location of the United States and its

increasing dependence on imported resources, combined with Soviet military buildup and global expansion, require that the United States be able to deploy military forces throughout the world on short notice.

Insufficient Mobility

The Department of Defense recognizes this need for rapid force projection capability. The Office of the Joint Chiefs of Staff stated in its Military Posture 1984 report (52), "The ability to rapidly deliver forces and material to a theater during the early stages of deployment is crucial to U.S. strategy." And the only means of rapidly delivering these forces is airlift. The Air Force Report for FY 1984, written jointly by the Secretary of the Air Force and the Air Force Chief of Staff (49), states:

> "In almost all instances the urgent early demands of a crisis must be met entirely by airlift. This airlift capability may mean the difference between victory and defeat."

To provide this airlift capability, the Air Force has 270 C-141s and 77 C-5As from the Military Airlift Command (22:96) and 383 commercial aircraft from the Civil Reserve Reserve Air Fleet (CRAF), U.S. air carriers who have contractual agreements with the Air Force to provide cargo and passenger aircraft during contingencies (29). Together, these aircraft can provide 28.7 million-ton-miles per day of

airlift.

Under many scenarios, however, this airlift is inadequate to deliver sufficient forces on short notice. Since 1974, various agencies have conducted over 17 force projection analyses, and all of them conclude that there is an airlift shortfall for meeting NATO, Korean, and Rapid Deployment Force movement requirements (26:21). One of these studies was the Congressionally Mandated Mobility Study (CMMS), initiated by Congress in 1981 to define mobility requirements. The CMMS recommended a wartime airlift capability of 66 million-ton-miles per day, more than twice our present capability. Secretary of Defense Caspar Weinberger (54) recognized this shortfall in his address to the American Newspaper Publishers Association in Chicago in May, 1981:

> In the middle of any night, I may be awakened to be told that the Soviet Union is actually in the process of invading a country that we must defend but where we have neither bases nor troops ... we [do] have contingency plans, but are our forces truly ready to carry them out? ... are we ready ... [for] swift military movements?

Our swift military movements are insufficient if the mobility studies are correct. And some suggest that our need for mobility is increasing. Lt Col Marshall E. Daniel, Jr., (10:1) USAF Senior Research Fellow at the National Defense University, predicts increasing demands in mobility

resources because of the increased tempo of future warfare:

> Analyses of recent conflicts, such as the 1973 Arab-Israeli encounter, suggest that the nature of future wars may differ considerably from that of past conflicts. These wars may exhibit a significant increase in the magnitude of violence, resulting in increased attrition of both personnel and equipment, and in vastly increased consumption of essentials such as POL (petroleum, oil, and lubricants), ammunition, and other expendable supplies. This increase in the tempo of warfare will place uncommon demand on the transportation resources that constitute U.S. strategic mobility capability.

Warning time for a conflict may also be shortened. Some predict that the Warsaw Pact could launch an attack with only two days preparation (3:20). Soviet military writings support this limited warning scenario (58:2-3), as does Secretary Weinberger, "We may not again have the preparation time we had to get ready for World War II, which [even then] was barely enough (55:47)." If less warning time is, in fact, the case, rapid strategic mobility becomes even more important.

Improving Strategic Mobility

Because of the shorter warning time, increased tempo of future wars, expanding global interests, and increasing Soviet military strength, Congress has concluded that the U.S. must improve its force projection capability.

To assist in meeting this need, numerous steps have

been taken to improve airlift capability, including modifying existing aircraft and acquiring new aircraft (16:62).

A modification recently completed was the stretching of 270 C-141 fuselages. The additional three pallet lengths provide 30% more cargo capacity, the equivalent of gaining 90 additional C-141s.

A modification currently in progress is the retrofitting of new wings for the C-5A. These specially treated aluminum alloy wings will extend the life of the C-5A by 30,000 hours, allowing service past the year 2000.

In addition to modifications, new aircraft are being acquired. Beginning in FY 1985, fifty new C-5Bs will be built, providing additional ability to carry outsize cargo, such as tanks and large trucks, air transportable only in the C-5.

The most recent addition to the Air Force fleet is the KC-10, a combination in-flight refueler and airlifter capable of carrying 170 passengers and 170,000 pounds of cargo in addition to its refueling capability. 44 KC-10s will be built by 1984.

These fleet modifications and additional aircraft will significantly increase our airlift capability. But a substantial shortfall will still exist, and the Department of Defense is now attempting to enhance an already existing

source of airlift: the Civil Reserve Air Fleet.

Civil Reserve Air Fleet Enhancement

Recognizing the additional need for airlift, and yet constrained by the high cost of acquiring new aircraft (the fifty C-5Bs will cost $1.3 billion (22:96), the Air Force is seeking to obtain an additional 5 million-ton-miles per day of airlift by a contractual arrangement with the airlines to modify several wide-bodied passenger aircraft for use as convertibles--passenger aircraft with side cargo doors and strengthened floors capable of carrying cargo by simply removing seats and adding floor rollers--thus providing additional cargo airlift in the event of a military emergency, while continuing to provide commercial passenger service during peacetime. The Air Force will reimburse the airlines for the additional costs of modifying and operating a convertible aircraft.

By enhancing the CRAF, the shortfall in strategic mobility can be reduced, countering the threat of Soviet expansion and protecting our interests in imported resources.

Statement of Problem

The airlines will incur several costs as a result of this CRAF Enhancement Program. The costs include the following:

1. Revenue lost due to aircraft's removal from airline operations for an eight week modification period

2. Modification costs of strengthening an aircraft's floor and adding a side cargo door

3. Additional fuel expense due to the increased weight of a heavier floor

4. Opportunity costs of not replacing the modified aircraft for 16 years

The Air Force must determine these costs in order to appropriately reimburse the airlines.

Objective

The objective of this thesis is to determine the costs incurred by an airline for modifying a Boeing 747 passenger aircraft for use as a convertible aircraft capable of carrying military cargo in the event of a national emergency.

Scope

This study will consider the modification costs of only one type of aircraft: the Boeing 747. The U.S. commercial airline fleet presently consists of ten jet aircraft types, but only three are wide-bodied (Boeing 747, DC-10, and L-1011) and capable of carrying oversize cargo. The L-1011 is

not being considered by the Air Force because convertible versions do not exist, and there are no designs or cost estimates available. Of the two remaining wide-bodies, this study will examine only the costs of converting the Boeing 747 because of its larger payload capability.

Organization of the Study

The next chapter examines the development of the civil/military relationship leading to the Civil Reserve Air Fleet, and discusses CRAF's recent Enhancement Program.

The methods for determining the costs of the Enhancement Program will be explained in Chapter III. Each of the four costs (removing an aircraft from operations for eight weeks, strengthening the floor and adding a side cargo door, increasing the operating cost of a heavier aircraft, and guaranteeing 16 years of operations of a modified aircraft) will be examined in detail.

Chapter IV applies these four costs to the Boeing 747, arriving at the total reimbursement for a modified Boeing 747.

Chapter V analyzes the resulting costs, and the last chapter presents a summary and recommendation.

CHAPTER II

DEVELOPMENT OF CIVIL/MILITARY AIRLIFT RELATIONSHIP

Introduction

The Civil Reserve Air Fleet Enhancement Program evolved from a long-standing relationship between civil and military aviation. This chapter discusses the origin of this relationship, then outlines the structure of CRAF and the need for enhancing CRAF's capability.

Establishment of the Civil/Military Airlift Partnership

Interest in airlift by the U.S. government first began in 1916 when the Post Office Department signed an airmail contract with private operators (37:54). Two years later, the Post Office organized its own air mail service using its own aircraft and pilots. This service expanded rapidly, and by 1920 extended from New York to San Francisco (12:77). It is significant that during this period the military contributed little in developing an airlift system, and the airplane's military role was limited to tactical and reconnaissance operations. The government did, however, foresee using the aircraft for passenger travel, and in 1925 Congress passed the Kelly Act, awarding airmail contracts to

what eventually became United, American, and Trans World Airlines, in hopes that the promotion of airmail contracts would enhance air passenger travel (37:4). This airmail system remained intact through the next decade, with the brief and tragic exception in 1934 of transferring the airmail responsibility to the Army, whose inexperienced pilots were unprepared for flying through severe weather in airplanes with inadequate instrumentation. The experiment with the Army lasted only two months, after which airmail contracts with the airlines resumed (39:59-60).

Through the mid 1930s the government still confined its interest in air transportation to the delivery of mail and development of passenger service. By 1937, however, Congress began recognizing commercial aviation's value to the military. A Senate Commerce Committee Report in 1937 (8:3121) expressed the military's need for the promotion of civil aviation:

> Military airplanes, in time of peace, cannot be advantageously stored in quantities, as can guns. There must [therefore] be ... a number of aircraft manufacturers and aircraft users distributed over the country and operated on a sound financial basis, creating an industry that is capable of rapid expansion to meet the Government's needs in an emergency ... Consequently, the general condition, productive capacity, and operative ability of our commercial aircraft establishment are of national concern.

During this period a series of acts were passed to promote and encourage the aviation industry. The last in this series was the

Civil Aeronautics Act of 1938 (47) creating the Civil Aeronautics Board and charging the Board with the following responsibility:

> (a) The encouragement and development of an air transportation system properly adapted to the present and future needs of the foreign and domestic commerce of the United States, of the Postal Service, and of the National Defense;
>
> (b) The regulation of air transportation in such a manner as to recognize and preserve the inherent advantages of, assure the highest degree of safety in, and foster sound economic conditions in such transportation, and to improve the relations between, and coordinate transportation by, air carriers;
>
> (c) The promotion of adequate, economical, and efficient service by air carriers at reasonable charges, without unjust discriminations, undue preferences or advantages, or unfair or destructive competitive practices;
>
> (d) Competition to the extent necessary to assure the sound growth of an air transportation system properly adapted to the needs of the foreign and domestic commerce of the United States, of the Postal Service, and of the National Defense;
>
> (e) The promotion of safety in air commerce; and
>
> (f) The promotion, encouragement, and development of civil aeronautics.

The Civil Aeronautics Act was significant in that it established economic regulation of the industry, controlling the airlines' entry and exit, routes, and passenger fares. It is also significant that civil aviation was kept separate from military aviation. There was much debate in America's first two decades of aviation as to whether civil aviation should be subordinated to the military. One proponent of

military control was Brig General William "Billy" Mitchell. He is well known for his efforts to create a separate arm of the military for aviation, ultimately being punished for carrying to the point of insubordination his protests, but it is not common knowledge that he specifically recommended the unification of civil and military aviation (42:30). Mitchell proposed a "Secretary of Air," within a department of defense, responsible for all forms of aviation--a proposal closely aligned with Great Britain's model. Mitchell further recommended that this aviation department set up and operate experimental airlines, creating governmental "corporations" that would eventually be made available to private operators once the financial data showed the operation to be viable. This process would be continuous, with the government testing and operating new aircraft, then passing on the operations to private investors (24:114-115).

Two important committees, however, disagreed with Mitchell. The first was the Crowell Commission, a civilian advisory body appointed by Secretary of War Newton D. Baker in 1920, which favored separation of military and commercial aviation (18:173). The second was the Morrow Board, initiated by President Coolidge in 1925 to formulate a national military and civilian aviation policy and led by Dwight W. Morrow, a well known lawyer, financier, and statesman. The Board was openly hostile toward Mitchell's proposals and directly stated that military and civil aviation should be

kept separate (32:6). (Mitchell (13:128-131) considered this report as one of the "blackest pages ever written into our Government's records," and one which "retarded our progress in aviation.") Mitchell and his colleagues lost their case, and civil aviation remained independent of its military counterpart, maintaining the traditional American notion that the government, especially the military, should neither organize nor dominate any important segment of the national economy (42:32-33).

Civil aviation not only remained separate from the military, but also avoided nationalization, contrary to the route that virtually all European nations took (2:7). Airlines such as Sabena (Belgium), Air France, Icelandair, Alitalia (Italy), Swissair, K.L.M. (Dutch). S.A.S. (Norway, Denmark, and Sweden) and Lufthansa (Germany) originated with and still retain full or partial state ownership. But Europe's situation was different, argued opponents of U.S. nationalized airlines: the close geographical proximity of European nations made airlines an instrument of foreign policy (42:26). The New York--Washington route is almost identical in length to the London--Paris route, but the U.S. route is not concerned with the political, economic, and military factors that affect European routes and should not be run by the government. America chose, therefore, to promote, but not nationalize, its airlines.

While the Civil Aeronautics Act of 1938 did not call for nationalization or military control of the airlines, it did emphasize the potential role of commercial aviation in the defense of the nation (" ... an air transportation system properly adapted to the present and future needs of ... the National Defense," from section (a)). This role, however, was not clearly defined, and it was not stated how civil aviation was to be employed in a defense emergency.

It took World War II to define that role. The general attitude before the war was that the airlines were something of a national reserve. This emanated from the tradition that transportation systems have a contribution to make to military preparedness. President Roosevelt felt that the airline industry was a "reservoir" of men and machines always available for the defense effort (19:73), and Eddie Rickenbacker, World War I aviator and later president of Eastern Airlines, considered airline pilots as "reservists" (37:89-90). The exact relationship between the airlines and the government evolved from an agreement between the Air Transport Association (the airlines' trade association) and the Secretary of War, whereby the government purchased over half of the existing airlines' fleet, then leased the aircraft back to the airlines, leaving the companies intact so as to operate with maximum efficiency (9:151). The airlines and the military integrated their efforts, establishing the Army's Air Transport Command (ATC) and the Naval Air Transport Service

(NATS). Key airline executives occupied important posts in ATC and NATS, such as American Airline's president C. R. Smith's position as Deputy Commander of ATC (7:50). Even the Air Transport Association took on a quasi-official status when it acted as the industry's command post in the Commerce Building, issuing War Department directives to the airlines, managing travel priorities, and deciding which carrier would give up aircraft to meet the War Department's requirements (7:58-59). As the ATC expanded, military and civilian pilots flew the same planes along the same routes, with both military and civilian ground crews stationed along the way. This airline arrangement allowed the airlines to contribute significantly to America's success in World War II, providing 88 percent of all air transport requirements (6:31).

The carriers were again called upon during the 1948-9 Berlin Crisis. The Soviet Union, in an attempt to force Western Allies out of Berlin, closed all railroad, barge, and autobahn traffic to West Berlin, leaving air as the only means of supplying food, fuel, and other resources for two and a half million West Berliners. The military responded by marshaling as many of its C-47s and C-54s as possible to Berlin, using C-121s, Navy aircraft, and commercial aircraft to meet other airlift needs (6:20). For fifteen months the military airlifted over 4,500 tons of cargo per day to Berlin (17:9), demonstrating that a massive amount of cargo

could be airlifted over a sustained period. But it also demonstrated the need for supplemental airlift from commercial carriers during airlift emergencies.

Development of the Civil Reserve Air Fleet

Recognizing the need for commercial augmentation, two study groups were tasked to examine our national aviation policy: the Presidentially appointed Finletter Commission and the Senate's Brewster Board. Their reports, both released in 1948, recommended that the airlines be considered a reserve, available for military use when necessary (53; 48). The Brewster Board stated: "Such an operating fleet serves peacetime commerce and industry, while remaining available for immediate conversion to military use in an emergency (48:15)." The Finletter Commission concurred: "The soundest way to build up a pool for military use is to develop a plane that can be operated commercially on a profitable basis (53:115)."

Based on these recommendations, and on later studies conducted by volunteer groups from the aviation industry, President Truman, in February 1951, issued Executive Order 10219 directing the development of plans and programs for assigning carrier assets to the Department of Defense to meet emergency needs (34:6). The result was the Civil Reserve Air Fleet Plan, written by the Secretaries of Commerce and Defense, with the participation of the airlines,

and signed on 15 Dec 1951. Under the new plan, the airlines were to provide 91 aircraft and their crews to the Military Air Transport Service, the predecessor of the Military Airlift Command (MAC), within forty-eight hours of notification. In return for guaranteeing those aircraft and as an incentive for participating in CRAF, peacetime military contracts were given to the participating carriers.

Much of the original agreement still remains in effect today, although the fleet is much larger now. Executive Order #11490, signed by President Nixon in 1969, transferred the responsibility for CRAF allocation from the Department of Commerce to the Department of Transportation, and the 1981 Memorandum of Understanding updated the agreement between the Department of Defense and Department of Transportation, but the concept of wartime commitments of specified airlines in return for peacetime airlift contracts is unchanged.

The next section describes the structure of CRAF, followed by the need for and attempts at enhancing the capability of CRAF.

CRAF Structure

The Civil Reserve Air Fleet as now constituted consists of 383 aircraft from 22 airlines, each available for call up in the event of a national emergency. 167 of the aircraft

are cargo aircraft, while the remaining 216 are passenger aircraft which will transport troops if activated.

These aircraft vary in size, from medium size turboprops to 4-engine jumbo jets, and are divided into four segments: Domestic, Alaskan, Short-Range International, and Long-Range International. The following describes each segment and lists their respective aircraft (34:21; 29):

Domestic

The Domestic segment, composed of DC-9s, and Lockheed L-100 (Hercules) and L-188 (Electra) turboprops, support two stateside cargo operations--Air Force's LOGAIR and the Navy's QUICKTRANS--both during peacetime and CRAF activation. LOGAIR is the air logistics pipeline between depots and Air Force installations, moving high value supply items daily. QUICKTRANS is the same type system used by the Navy to provide logistics support to major Navy fleet centers in the U.S.

Alaskan

The Alaskan segment of CRAF supports Alaskan airlift requirements of the Alaskan Air Command and the Distant Early Warning (DEW) radar sites. This segment is composed of the Boeing 737s, L-188s, and L-100s.

Short-Range International

The Short-Range International Segment supports MAC's role of intra-theater airlift, as well as short-haul operations from the continental U.S. to such near offshore locations as the Carribean, Greenland, and Iceland. This segment is composed of Boeing 727s and DC-8s, with a productive payload range of approximately 1500 nautical miles.

Long-Range International

The Long-Range International Segment, of which this study is concerned, provides support for world wide mission requirements. This segment contributes significantly to the nation's airlift capability. 90% of wartime troop movements and 38% of total cargo movements come from this segment of CRAF, with the remainder provided by MAC aircraft (23:III-11). The Long-Range International Segment consists of the Boeing 747s, DC-10s, L-1011s, Boeing 707s, and DC-8s. Their capabilities are as follows (See Figure 2.1 for comparing relative sizes):

Boeing 747

Wide-bodied aircraft capable of carrying either cargo, passengers, or both; maximum payload of 99.1 tons (4500 nautical miles (nm)) or 419 passengers (5100 nm)

McDonnell Douglas DC-10

Wide-bodied aircraft available in cargo or passenger versions; maximum payload of 69.9 tons (3350 nm) or 359 passengers (4500 nm)

Lockheed L-1011

Wide-bodied aircraft designed to carry only passengers (no cargo version exists); maximum payload 274 passengers (3075 nm)

Boeing 707

Narrow-bodied aircraft available in cargo or passenger versions; maximum payload of 29.9 tons (3750 nm) or 149 passengers (4400 nm)

McDonnel Douglas DC-8

Narrow-bodied aircraft available in cargo or passenger versions; maximum payload of 41.1 tons (2800 nm) or 264 passengers (3600 nm)

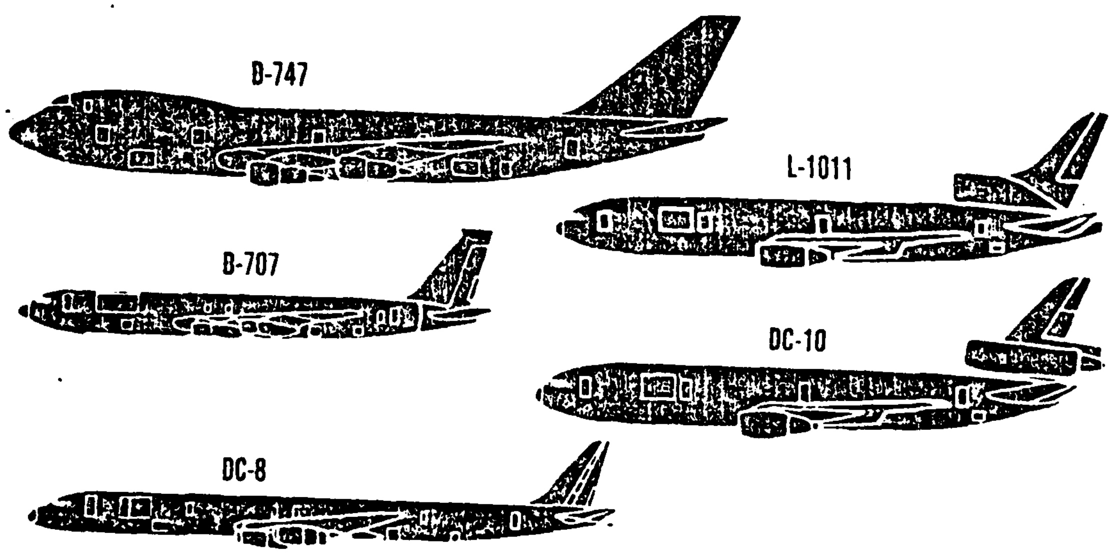

Figure 2.1 CRAF Long-Range International Aircraft

CRAF Activation

When CRAF was originally designed, activation called for either full mobilization or none at all. This prevented partial activation to support minor contingencies, and was therefore amended in 1963 to provide three stages of activation:

Stage I, Committed Expansion

This stage is intended to respond to low level conflicts and is activated by the Commander of the Military Airlift Command. Peacetime procedures remain in effect, as Stage I is only an expansion of contractual airlift supplementing MAC aircraft. Stage I aircraft must be available within 24 hours notice.

Stage II, Airlift Emergency

Activated by the Secretary of Defense, this stage supports a major contingency not warranting full mobilization or the declaration of a national emergency. Response time is 24 hours.

Stage III, National Emergency

This stage includes all aircraft in CRAF and is activated by the Secretary of Defense following the declaration of a national emergency by the President or Congress. Carriers must respond within 48 hours.

Figure 2.2 shows the number of Long-Range International aircraft committed to each stage as of 1 April 1983.

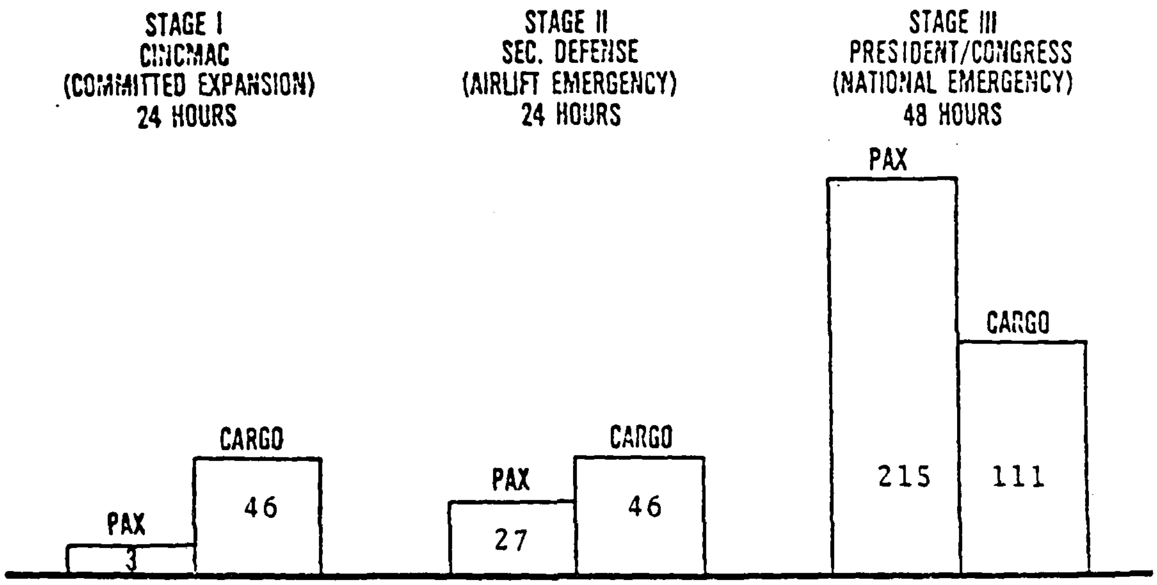

Figure 2.2 Long-Range International Aircraft Contribution

This incremental activation gives the Department of Defense flexibility in its response to crises and theoretically lessens the impact of a CRAF activation on the nation's air transportation system. None of the stages has ever been activated, although the carriers have voluntarily expanded airlift to nearly Stage I levels on two occasions: The TET Offensive and the evacuation of Viet Nam, just prior

to its fall (2:47).

Shortfall of Airlift Capability

As indicated, Stage III activation provides 111 Long-Range International cargo aircraft (11 Boeing 707s, 50 DC-8s, 34 Boeing 747s, and 16 DC-10s), contributing 10.9 million-ton-miles/day. While this cargo capability is significant, there is still a large shortfall in meeting the CMMS recommended wartime capability of 66 million-ton-miles (mtm)/day. Our present capability of 28.7 mtm/day, combining MAC aircraft and CRAF, is less than half the recommended airlift capability. The programmed acquisition of fifty C-5Bs and forty-four KC-10s by 1988 will add 12 mtm/day, still leaving a shortage of airlift capability. To assist in reducing this shortfall, the conversion of Boeing 747 and DC-10 passenger aircraft to cargo-capable carrying aircraft has been proposed. The next section describes the background and current status of this CRAF Enhancement Program.

CRAF Enhancement

Modifying passenger airliners for potential military cargo use was originally proposed in 1974 (33). Several carriers responded to the proposal, and the House of Representatives passed legislation supporting the modification. The Senate, however, failed to enact any legislation and the bill was dropped. In 1979 funding was again recom-

mended, this time by the Senate, but the airline carriers rejected the offer because of increasing fuel prices and the resulting higher costs from operating heavier aircraft. The Senate therefore recommended reimbursement to the airlines for the escalating prices in fuel. A Request For Proposal (RFP) was subsequently issued in April 1982, with carriers identifying 53 aircraft for potential modification. The RFP expired, however, before the Secretary of Defense took action. Since then a new RFP was approved by the Secretary of Defense in June 1983, and contracts with the airlines are to be completed by September 1983.

Summary

The civil/military airlift relationship has evolved from the Post Office's interest in aviation in 1916 to today's highly structured Civil Reserve Air Fleet, which provides almost one half of the nation's strategic airlift. CRAF can provide even more airlift through the CRAF Enhancement Program. Of interest to the Air Force, and the purpose of this study, is determining the appropriate reimbursement to the airlines for modifying existing passenger Boeing 747s. The next chapter will describe the methods for determining the cost of this modification.

CHAPTER III

METHODOLOGY

Introduction

Chapter II outlined the development of the civil/military airlift relationship and the need for CRAF Enhancement. It was also shown that the airlines provide a significant portion of our strategic airlift. It must be remembered, however, that while airlines are a national asset and useful in time of war, they foremost are profit seeking corporations participating in America's free enterprise system. Their success is measured not by the degree of assistance they render the U.S. Government, but by their ability to generate revenues in excess of the costs incurred in producing those revenues. As such, any modification to their aircraft on behalf of the nation's defense must be done so without hindering their profitability. CRAF Enhancement costs must be fully covered, and include the following: revenue lost during the modification, the modification cost itself, additional costs due to operating a heavier aircraft, and any loss attributed to the continued operation of an aircraft that would otherwise have been replaced.

This chapter will examine each of these four costs, and

explain the methodology used in chapter IV to calculate these costs, insuring that the airlines receive a fair and reasonable reimbursement that will neither hinder their profit objective, nor unfairly advance their position relative to their competitors.

Net Revenue Lost During Modification

Introduction

An aircraft produces revenue; it also generates costs. If an aircraft is taken out of service, it no longer produces revenue, nor does it generate as many costs. An airline's loss for removing an aircraft for two months is therefore determined by subtracting from the lost revenue those costs that are no longer incurred:

  Revenue Lost During Modification
- Costs Not Incurred

  Net Revenue Lost During Modification

Revenue Lost During Modification

When an aircraft is removed from service, not all of the revenue generated by passengers and cargo will be lost. The airline may take action to maintain some of its revenue, and the customer's response to a change in schedule may retain some of the revenue.

The airline can attempt to maintain its revenue by increasing the utilization of other aircraft in its fleet to

cover the lost routes. More hours per day would be flown on the remaining aircraft. There are two reasons, however, why this is difficult to accomplish. The first is that adding additional routes to those aircraft already flying means rescheduling departure and arrival times, and the customers' needs may not be met by these new times. Air travel fluctuates throughout the day and throughout the week. Departures draw the most travelers at 9 A.M. and 5 P.M., and weekly peaks are on Friday and Sunday (56:xxxc,xxxci). Tables 3.1 and 3.2 show this variability of demand by the hour and day.

Table 3.1

Variability of Demand for Air Travel, by Hour of Departure

Hour of Departure	Traffic as Percent of Peak Hour
1 A.M.	15
2	6
3	4
4	3
5	2
6	3
7	29
8	71
9	93
10	77
11	66
12 (noon)	74
1 P.M.	71
2	64
3	74
4	78
5	100
6	99
7	96
8	58
9	56
10	37
11	22
12 (midnight)	15

Table 3.2

Variability of Demand for Air Travel, by Day of Week

Day of Week	Traffic as Percent of Peak Day
Monday	90
Tuesday	88
Wednesday	93
Thursday	98
Friday	100
Saturday	84
Sunday	98

Covering lost routes with the existing aircraft may therefore be impractical if it results in unpopular departure and arrival times.

The second reason it is difficult to increase the utilization rate of the remaining aircraft is that many Boeing 747s, particularly those flying international routes, are idle only a few hours per day. In 1982, the Boeing 747 fleet for all U.S. carriers averaged 10.14 block hours per day (block time is measured from when the blocks are removed before departure to when they are replaced at the next station) (45). In addition to block time, additional time is needed for passenger enplanement and deplanement, baggage and cargo handling, refueling, post and pre-flight inspection, and non-routine maintenance. The remaining time in which the aircraft is idle is not sufficient for an additional flight. An average Boeing 747 flight is 5.4 hours (45), too long to be added to the daily schedule, and a

flight of short duration would be uneconomical for a Boeing 747. Two or three hours of idle time is therefore of little use to a Boeing 747 typically flying long routes.

It is thus difficult for the airlines to replace the lost sorties with their remaining aircraft. Peak departure times and the already high utilization rate prevent additional flights. If it was easy for the airlines to increase their aircraft utilization rate, they would not have use for all of their aircraft in the first place. There is therefore little likelihood that the airlines could substitute remaining aircraft for the aircraft in modification.

Some revenue may be retained, however, depending on the customer's actions. A customer may transfer to another flight with the same airline, if another is available, or postpone the trip until the modified aircraft is returned to service. The customer's other alternatives are to change to another airline, change the mode of travel (auto, bus, train, ship, or truck (if shipping cargo)), or cancel the trip. Predicting customer response is difficult. If there are no competing airlines, or if customer loyalty is high, a customer could either switch to another flight on the airline or postpone the trip until the modified aircraft is returned to service, thus maintaining the same level of revenue. If there is competition, however, the customer could switch airlines, thus creating a loss of revenue.

Because there is intense competition among the airlines (both domestic and foreign), and because of the competitive effects of deregulation and the uniformity of customer service, it is probable that a significant number of customers will switch airlines, thus depriving the original airline of its revenue.

Loss of revenue, then, is a function of both airline rescheduling and customer response. Airlines will attempt to retain customers by increasing aircraft utilization; and customers may either remain with the airline, switch airlines, switch mode of travel, or cancel their trip.

Because the airlines have difficulty increasing a Boeing 747's utilization rate, and because of the high level of competition and resulting loss of customers, this study will assume that 75% of the revenue generated by an aircraft will be lost when that aircraft is removed from the fleet.

Costs Not Incurred

This lost revenue is not without some savings. Not operating an aircraft will definitely reduce expenses. The amount of this reduction, however, is less than one might expect. Operating an aircraft involves six expenses, most of which are incurred regardless of aircraft use. This section will describe each expense, and the impact on those expenses of removing an aircraft from the fleet for eight

weeks.

Crew Cost. The crew of a Boeing 747 consists of three flight officers (pilot, co-pilot and flight engineer) and at least seven or eight flight attendants, depending on the number of seats in the aircraft (the Federal Aviation Agency requires one flight attendant for every 50 seats, independent of the number of passengers on board (51), and airline policy regarding degree of service. An aircraft taken out of operations requires no crew. The salaries of the crews, however, will likely be paid, depending upon the union contract. Furloughed pilots and flight engineers continue to receive approximately two weeks pay for every year of employment, up to a maximum of 22 weeks pay (14). Because Boeing 747 flight officers are generally the most senior and bid for the largest aircraft, all have more than four years of service and will receive their full pay during the eight week modification period regardless of whether they fly. An airline would probably keep all flight officers flying in order to maintain currency, and reduce their hours, still paying their full salaries.

Flight attendants have similar layoff provisions. And although they do not bid for the type of aircraft, they do bid for routes, with the most senior generally desiring longer routes, typically flown by Boeing 747s (14). Thus flight attendants for the Boeing 747 are also senior, and

will continue to draw pay regardless of working schedules. Crew costs, therefore, will not decrease when a Boeing 747 is removed for modification.

Fuel and Oil. Unlike crew costs, fuel and oil costs will cease during the modification since the aircraft will not be flown.

Insurance. Insurance included in the direct operating costs of an aircraft covers both the hull (airframe and engines) and liability (people and property, both on the ground and in the air) (4). Premiums for hull insurance are based on the value of the insured aircraft. Liability premiums, however, are based not upon an individual aircraft, but on an airline's entire fleet and the total number of passenger miles flown each year.

Most of the costs for insurance will remain during the two month modification. Hull insurance cannot be dropped because of the possibility of damage during the modification. And liability insurance can be reduced only to the extent that an insurance company would reduce payments for a period as short as two months.

Because of these restrictions, and the continuing need for hull insurance, this study will assume that insurance costs will decrease by only 20% during the aircraft's modif-

ication.

Taxes. Taxes attributable to direct operating costs are the fuel and oil taxes paid to the federal government. During the modification period, no fuel or oil will be purchased and, hence, no taxes will be paid.

Maintenance. An aircraft in the process of modification will not have normal maintenance requirements. Most of the maintenance costs, however, will remain, primarily because of labor and overhead costs.

Maintenance costs are divided into Direct Maintenance Costs, including labor and material, and Applied Maintenance Burden, or indirect maintenance costs, attributable to areas such as record keeping, training, and utilities. Figure 3.1 breaks down the Total Maintenance Costs.

An aircraft removed from the fleet no longer requires any direct maintenance. But, as with crew costs, labor costs remain. Layoff provisions require a continuation of pay throughout the eight week period for all but the most junior employees, and there has been very little hiring the past three years among the five airlines with Boeing 747s. With labor costs remaining during the modification period, the only reduction in Direct Maintenance Costs will be for material.

There will be no reduction in Applied Maintenance Burden due to the nature of indirect costs. Therefore, of the Total Maintenance Costs, only material costs will decrease during modification.

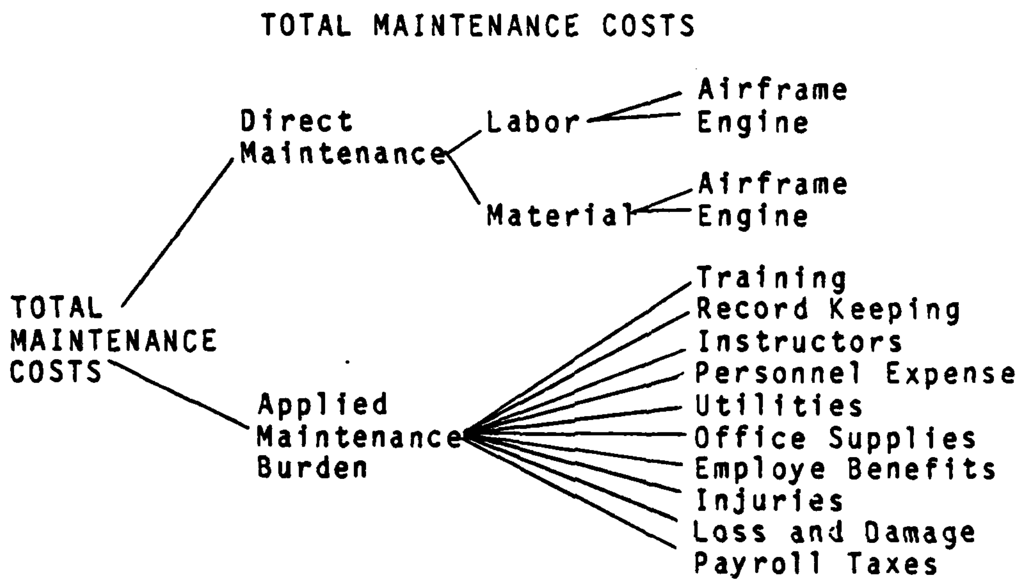

Figure 3.1

Depreciation. The final cost directly attributable to aircraft operations is depreciation, or the process of allocating the original aircraft's cost over a several year period. Depreciation accounts for the gradual obsolescence of equipment (36:244). While it is impossible to know exactly how long an aircraft will benefit a company or how much it can be sold for at the end of its useful life, airlines select a specific length of time and report the resulting depreciation as an annual expense. Depreciation

thus becomes a direct operating cost for the aircraft. The number of years of useful life specified for a Boeing 747 varies among the five airlines. Table 3.3 shows the useful life that each airline has allocated to its aircraft.

Table 3.3

Boeing 747 Useful Life, by Airline

AIRLINE	USEFUL LIFE (years)
American	14
Pan Am	16-22
Northwest	15
United	16
TWA	16

Source: (1:32; 31:26; 28:23; 44:31; 43:30)

The cost attributable to depreciation will vary for each airline due to different useful lives, ages, and values of the aircraft. During modification, the airline will continue to depreciate their aircraft, thus there is no reduction in the cost attributable to depreciation.

<u>Summary of Costs.</u> This section on aircraft operating costs has shown that despite the grounding of an aircraft for two months, numerous costs are still incurred. All of the costs for crews, maintenance labor, depreciation, and 80% of the insurance costs will remain. Reductions in cost will be fuel and oil, taxes, maintenance material, and 20% of the insurance.

Determining Actual Revenue and Costs

The amount of revenue generated by an airline's Boeing 747 is not disclosed to the public. However, aggregate data from all five U.S. airlines flying the Boeing 747 is available and will be used in this study. The results will therefore reflect the appropriate reimbursement for an average Boeing 747. 1982 data will be used to calculate the revenue that a Boeing 747 could be expected to generate over one year. A proportion of 8 weeks out of 52 (8/52) will be used to determine the amount of revenue that a Boeing 747 could otherwise be expected to earn during the modification. Of this amount, 75% is expected to be lost, as explained earlier in the chapter.

After the amount of revenue lost has been determined, the costs that are no longer incurred will be subtracted from lost revenue. Fuel and oil, taxes, maintenance material, and 20% of the insurance costs, all measured in dollars per block hour, are added together and multiplied by the number of block hours normally flown in eight weeks. This amount subtracted from the lost revenue results in the total loss incurred by an airline for removing an aircraft for modification.

Summary of Net Revenue Lost During Modification

An airline's loss for the eight week removal of its

aircraft is dependent upon the amount of revenue it is unable to retain and the costs that are no longer incurred. This study assumes that the airlines will lose 75% of an aircraft's normal revenue because of hourly and daily passenger demand and high utilization of the remaining Boeing 747s. And several costs will still be incurred because of contract provisions, continuing depreciation, and other recurring costs.

The remainder of this chapter addresses the cost for the modification itself, the increased costs of operating a heavier aircraft, and the opportunity cost of keeping the modified aircraft in the fleet for 16 years.

Modification Costs

Boeing 747 passenger aircraft are incapable of transporting the heavy equipment required for military movements. The floor under the passenger seats will not support the required weight, and the cargo door at the aft end is too small for large equipment. The modification will therefore strengthen the floor, allow rollers to replace seats, and add a side cargo door. This section describes these modifications, and explains the contractual arrangements.

The modified floor must be capable of supporting a total cargo weight of 167,000 pounds, and the side cargo door must be 120 inches high (measured from the top of the

cargo rollers) and 134 inches wide. Additionally, the seats must be able to be removed and rollers installed in less than 48 hours (23:Part C,Sec.1). This modification cannot be accomplished by the airlines due to their lack of machinery and skilled personnel. The aircraft will therefore be sent to a modification center, probably an existing aircraft manufacturer (hereafter referred to as the modifier). Detailed work specifications will be given to the modifier by the airlines, with approval of the Air Force and the Federal Aviation Agency.

The price for this modification will be negotiated by the Air Force, and auditing of the modifier's proposed price will be accomplished by the Defense Contract Audit Agency (DCAA).

An estimate of the modification cost has already been submitted by one manufacturer, the Boeing Company. Although Boeing's proposal has not yet been accepted, this study will use their estimate in determining the cost of the modification.

Summary

Modification requires strengthening the aircraft floor and adding a side cargo door. The modification requirements will be submitted by the airlines to an airframe modification center, with Air Force and Federal Aviation Agency

approval. Price negotiations will then be conducted between the modifier and the Air Force. For purposes of this study, a current estimate by Boeing will be used.

Increased Operating Costs

A convertible aircraft is more expensive to operate than a passenger aircraft because of three increased costs: Fuel, Engine Maintenance, and Insurance. The first two increased costs, fuel and engine maintenance, result from operating a heavier aircraft; and the third increase, insurance, results from the increased value of a convertible aircraft. This section discusses each of these increased operating costs, and the method of reimbursing the airlines for these increased costs over a 16 year period.

Fuel

The most significant increase in costs comes from the additional fuel required for operating a heavier aircraft. The aircraft floor, reinforced for potential accommodation of a roller system and military cargo, adds approximately 12,000 lbs to the aircraft's basic weight (41). This additional weight increases the aircraft's drag, or resistance, which increases fuel consumption, which in turn requires a corresponding increase in thrust, thus increasing the fuel consumption.

Engine Maintenance

The increased requirement for thrust also causes greater wear on the engines, thus increasing the cost of engine maintenance (40).

The additional weight of a modified aircraft therefore increases not only fuel costs, but engine maintenance costs as well.

Insurance

The final increase in operating costs is a higher insurance premium, resulting from the increased value of a modified aircraft. Only hull insurance (airframe and engines) must be increased; liability insurance will remain the same.

Calculating Increased Operating Costs

Reimbursement for these additional operating costs must cover the next 16 years. To determine this amount, the difference between passenger and convertible operating costs per hour must be multiplied by the number of hours flown per year for the average Boeing 747. The result will be the appropriate reimbursement for one year's additional operating cost.

Calculations must now be made to determine the reimbursement for 16 years. This amount cannot be determined, however, by simply multiplying one year's additional

operating cost by 16. Two factors prevent this simple calculation: future increases in operating cost differentials, and the time value of money. Both of these will be discussed, followed by an explanation of the method used to calculate the appropriate reimbursement for the 16 year period.

Increasing Cost Differentials. The operating costs for fuel, engine maintenance, and insurance are higher for a convertible aircraft. The amount of these differential prices are expected to change over the next 16 years, and should be reflected in the reimbursement.

Fuel. From 1978 to 1981, the price of jet fuel increased 153 percent to a peak price of $1.05 for domestic fuel ($1.17 for international fuel) in May 1981 (50:18). Since then, an oversupply of fuel and a depressed world economy have lowered jet fuel prices by 10 percent. However, the Federal Aviation Administration expects a return to increasing prices, and forecasts an 8.4 percent rise through the next ten years, projecting a price of $2.65 per gallon by 1994 (50:19).

A change in the price of fuel will correspondingly affect the cost differential of operating a heavier aircraft, and rising fuel prices will increase the difference between operating a passenger and a convertible aircraft. To account for this rising cost differential, the

reimbursement by the government for fuel costs will increase by 10 percent each year. Thus, by the 16th year the compensation for additional fuel costs will be 4.6 times that of the first year, or a factor of $(1.10)^n$. Because of the variability in forecasting fuel prices, adjustments will be made annually for the actual cost of the previous year's fuel. Thus, each year the account will be updated.

Engine Maintenance. The cost differential for engine maintenance may also be expected to increase. The increased thrust requirement may create increasing wear on the engines, causing components to wear out at a greater rate than those of the unmodified aircraft. The increased rate should be minimal, however, due to the continuous overhaul and replacement of spare engine parts (40). This study will therefore assume an annual 2 percent increase in engine maintenance costs, or a factor of $(1.02)^n$ for each year, n, of operation.

Insurance. The increased cost of hull insurance should not change over the 16 years. It will be assumed that changes in the cost of insurance will be the same for both modified and unmodified aircraft.

Time Value of Money. Having determined the future reimbursement for fuel, engine maintenance, and insurance, the Air Force could simply pay the airlines the established amount on an annual basis for the next 16 years. The amount

of each year's payment would be calculated as follows:

YEAR	COST DIFFERENTIAL
1	Δ Fuel (1.10) + Δ Maintenance (1.02) + Δ Insurance
2	Δ Fuel (1.10) + Δ Maintenance (1.02) + Δ Insurance
.	. . .
.	. . .
.	. . .
16	Δ Fuel (1.10) + Δ Maintenance (1.02) + Δ Insurance

The contract, however, does not establish annual payments, but rather one single payment made upon delivery of the aircraft to the modifier. The Air Force must therefore combine all future payments into one.

If the value of money was constant over time, the one payment could be determined by adding together the above costs for all 16 years. But the value of money changes over time. An investment made today, because of the productivity of capital resources, grows to a greater value in the future. The rate at which it grows reflects productivity and is represented by interest, or profitability in terms of rate of return on the investment. The increase in value caused by the interest can be likened to depositing money in a bank savings account and observing the amount of money originally invested compound itself over time to a greater sum. Because there is a time value of money, the Air Force should not pay the airlines a sum equal to all 16 years' payments, but should instead reduce, or discount, the amount to its present value using the rate of return forecast for

the airlines over that period. By virtue of an airline investing the lump sum payment made at the inception of the contract in its own operations, it will accumulate that amount calculated each year as reimbursement for incurred costs.

Choosing this rate is accomplished through negotiation: if a firm has the choice between an amount of money in the future and a lesser amount today, which choice will be made depends on the rate of return the firm expects on its money. The airlines do not want their present payment discounted at a rate greater than they can invest their money; and the Air Force does not want to discount at a rate less than the rate at which the airlines can invest. Ideally, the discount rate will permit the airlines to invest the Air Force's payment at the same interest rate as the discount and thus exactly meet each year's costs.

Negotiations between the airlines and the Air Force resulted in a discount rate of 8 percent (20:B-6). Using this discount rate, the Air Force must determine how much money needs to be paid now (Present Value) to reimburse the airlines for recurring costs incurred in the future.

The following formula calculates this amount for any given year:

$$PV = F\frac{1}{(1+i)^n}$$

where PV = Present Value

F = Future Amount in year n to be Discounted

i = interest rate

n = number of years

Each year must be calculated separately, since the value of F will change annually due to increasing cost differentials. Combining the above formula with increasing cost differentials result in the following equation for the total 16 year reimbursement for operating a heavier aircraft:

$$PV = \sum_{n=1}^{16} \frac{\Delta\, Fuel(1.10)^n + \Delta\, Maintenance(1.02)^n + \Delta\, Insurance}{(1.08)^n}$$

Summary of Increased Operating Costs

The increased costs for operating a heavier aircraft can thus be determined by incorporating both the increasing cost differentials and the time value of money. The cost differentials are a result of projected increases in fuel

prices and an increasing rate of engine deterioration due to higher thrust requirements. The time value of money reflects the present value of reimbursements paid now for costs incurred later.

Opportunity Cost

Introduction

The three expenses examined thus far (net revenue lost during modification, modification cost, and increased operating costs) will result in a substantial investment by the Air Force. To preserve that investment, the Air Force would like the modified aircraft to remain in the fleet for as long as possible. Contract provisions therefore require that an airline guarantee the Air Force access to its modified aircraft for 16 years or else pay a refund penalty. An airline may sell or lease its aircraft during this 16-year period, but the purchaser or lessee must be a certificated U.S. air carrier who agrees to continue the CRAF obligation. If this criteria is not met, a refund penalty will be assessed, based on the number of years remaining in the 16 year contract.

Opportunity Cost

The question is raised as to whether this guarantee places a financial burden on the airlines. Is there an "opportunity cost" of keeping a modified aircraft in the

fleet for 16 years? An opportunity cost is defined as the amount of money that could be earned by putting financial resources to the best alternative use compared with the one being considered (36:567). Here the opportunity cost would be the cost of not replacing an aircraft that may become obsolete prior to the 16 year contract termination. If it can be shown that the Boeing 747 will likely remain an economically useful aircraft in the future, or that if it is not economically useful the penalty for selling to an unqualified buyer is minimal, then there is no opportunity cost. This section will address this question, examining the future demand of the Boeing 747, and the effect of the refund penalty for selling to an unqualified buyer.

Future Boeing 747 Demand. To determine whether there is a significant opportunity cost of retaining a potentially undesirable aircraft, the future use of the Boeing 747 must be considered. The following discusses the present and future demand of the Boeing 747, and the possibility of near term obsolescence.

Although the first Boeing 747 was delivered in 1969, production is still continuing today, and there are presently 147 Boeing 747s, including passenger and cargo versions, among the nation's airlines (56:72), and throughout the world 66 airlines fly Boeing 747s (27:139). Forecasts indicate that the demand for additional Boeing

747s extends into at least the next decade. Mr. Frank Spencer, Associate Professor of Transportation Management at Northwestern University, interviewed chief executive officers of several major airlines asking them of their aircraft needs from 1985 to 2000 (39). The response showed significant support for continued use of the Boeing 747, causing Mr. Spencer to conclude that "the Boeing 747's market position is impregnable." Boeing Airplane Co. also feels confident of the Boeing 747's future market. Mr. Clarence F. Wilde, Vice-President for Boeing's Commercial Sales, predicts that demand for Boeing 747s will increase toward the end of the 1980s, and that significant changes to the Boeing 747 will not occur until at least 1990, when the aircraft may be stretched to provide more cargo and passenger capacity (41). These forecasts are also supported by the independent aviation marketing company, AVMARK, Inc., which predicts a worldwide demand of 890 new long range widebodies between 1982 and 2000. If these forecasts are accurate, the need for an aircraft such as the Boeing 747 will continue for at least the next decade.

Refund Penalty Schedule. Beyond the next decade the airline's penalty would be small, even if it did sell to an unqualified buyer. The refund penalty for selling or leasing a modified aircraft to an unqualified carrier is assessed only through the first 12 years, with the earlier

years requiring a higher penalty than the latter, and no penalty for years 13 through 16 (See Table 3.4).

Table 3.4

REFUND PENALTY SCHEDULE

YEAR	% of ORIGINAL PAYMENT
1	100
2	100
3	83
4	75
5	67
6	58
7	50
8	42
9	34
10	25
11	17
12	8
13-16	0

The purpose of this refund penalty is to encourage the airlines to provide the Air Force long term accessibility to modified aircraft. The penalty decreases rapidly to one-half in seven years and one-fourth in ten years, thus minimizing the effect of selling to an unqualified buyer.

Conclusion

Because of the demand for Boeing 747s, and because there are presently no plans for any aircraft manufacturer to design a Boeing 747 replacement, there is little risk of obsolescence within the next ten years. Beyond ten years, the refund penalty reduces to 25% year, minimizing the effect of replacement beyond that point. Because of these factors, and because the airlines have the option of selling

or leasing to a qualified carrier without any penalty, there should be little or no opportunity cost of complying with the Air Force's 16 year provision. This study will therefore assume that no additional funds need be paid by the Air Force for an airline's opportunity cost of requesting 16 years of CRAF commitment.

Summary

Each of the four costs have been described, along with the methodology used to calculate these costs. Determining the total cost incurred by an airline for converting a Boeing 747 passenger aircraft is accomplished by adding together the four costs:

Net Loss of Revenue During Modification	\$ ________
Modification Cost	\$ ________
Increased Operating Cost	\$ ________
Opportunity Cost	\$ ________
TOTAL	\$ ________

The following chapter calculates these costs, and determines the total cost of modifying one Boeing 747.

CHAPTER IV

RESULTS

Introduction

Chapter III explained each of the four costs and the methods for determining those costs. This chapter will apply these methods and calculate the total reimbursement for modifying one passenger Boeing 747:

Net loss of Revenue During Modification	$ ________
Modification Cost	$ ________
Increased Operating Costs	$ ________
Opportunity Cost	$ ________
TOTAL COST	$ ________

Because individual airline data is not available, aggregate data from the five U.S. airlines operating the passenger Boeing 747 will be used, arriving at an average cost. The revenues and costs upon which the total reimbursement will be calculated are from 1982. Table 4.1 shows 1982 operating and cost data for the Boeing 747.

Table 4.1

1982 Boeing 747 Operating and Cost Data

Number of Boeing 747s per Airline:

AIRLINE	BOEING 747s
American	14
Northwest	29
Pan Am	45
TWA	18
United	18
TOTAL	124

Total 1982 Revenue for Boeing 747 Fleet: $5,568,933,000

Average Costs per Block Hour

Crew	$ 829
Fuel & Oil	3552
Insurancel	3
Taxes	43
Direct Maintenance	
Material	219
Labor	296
Applied Maintenance Burden	473
Depreciation	677
Total Aircraft Expenses per Block Hour	$ 6102

Average Utilization Rate: 10.14 Block Hours/Day

Source: (56:72; 45)

Net Loss of Revenue During Modification

During the eight week modification period, both revenues and costs will decrease. The revenue that will be for-

feited for eight weeks is calculated by dividing the annual revenue for the entire fleet by the number of aircraft in the fleet, then determining the amount of revenue lost for 8 weeks, or 8/52 of a year. 75% of this amount will be considered lost revenue. The following calculates the lost revenue for the eight week modification period.

Revenue Lost for 8 Weeks

1982 revenue for Boeing 747 fleet	$	5,568,933,000
÷ 124 (number of aircraft in fleet)		÷ 124
= Revenue per aircraft	$	44,910,750
x (8/52) (revenue for 8 weeks)		x 8/52
	$	6,909,346
x 75% (portion of revenue lost)		x .75
= Revenue Lost	$	5,182,009

The above calculation shows that $5,182,009 of revenue will be forfeited during an aircraft's eight week absence. Costs not incurred must now be calculated.

Costs Not Incurred

Determining the costs not incurred is accomplished by adding together the hourly costs for Fuel & Oil, Taxes, Maintenance Materials, and 20% of the Insurance, then multiplying this hourly rate by the average block hours flown per day by a Boeing 747. This amount can then be multiplied by 8 weeks, or 56 days:

Fuel & Oil	$ 3,552	
Taxes	43	
Maintenance Material	219	
.20 Insurance	3	
Total		$ 3,817
x Block Hours per Day		x 10.14
		$ 38,704
x 56 Days (8 weeks)		x 56
= Total Costs Not Incurred		$ 2,167,445

The difference between Revenue Lost and Costs Not Incurred equals Net Revenue Lost During Modification:

Revenue Lost	$ 5,182,009
- Costs Not Incurred	- 2,167,445
Net Revenue Lost During Modification	$ 3,014,564

Thus the first reimbursement will be $3,014,564 for net loss of revenue.

Net Loss of Revenue During Modification	$3,014,564
Modification Cost	$________
Increased Operating Costs	$________
Opportunity Cost	$________
TOTAL COST	$________

Modification Cost

The second cost covers the structural modification itself. The current estimated cost, although no contracts have yet been signed, is $14,300,000.

Net Loss of Revenue During Modification	$	3,014,564
Modification Cost	$	14,300,000
Increased Operating Costs	$	________
Opportunity Cost	$	________
TOTAL COST	$	________

Increased Operating Cost

The third cost to be determined is the increased expense of operating a heavier and more valuable aircraft. Fuel, Engine Maintenance, and Insurance will increase the costs for a convertible aircraft. The hourly differences in cost between passenger and convertible Boeing 747s are as follows:

FUEL	$ 85.39
ENGINE MAINTENANCE	17.77
INSURANCE	1.09

source: (41)

Multiplying these hourly figures by the utilization rate of 10.14 hours per day, and then by 365 days per year gives the basic cost differential used in the total cost equation outlined in Chapter III:

$$PV = \sum_{n=1}^{16} \frac{\Delta\, Fuel(1.10)^n + \Delta\, Maintenance(1.02)^n + \Delta\, Insurance}{(1.08)^n}$$

$$PV = \sum_{n=1}^{16} \frac{(85.39)(10.14)(365)(1.10)^n + (17.77)(10.14)(365)(1.02)^n + (1.09)(10.14)(365)}{(1.08)^n}$$

The present values for each of the 16 years and their sum are shown in Table 4.2.

Table 4.2

YEAR	PRESENT VALUE
1	$ 387,759
2	389,974
3	392,524
4	395,386
5	398,567
6	402,022
7	405,781
8	409,816
9	414,137
10	418,690
11	423,517
12	428,611
13	433,946
14	439,529
15	445,357
16	451,399
TOTAL	$ 6,637,015

Thus, the cumulative reimbursement for increased operating costs is $6,637,015.

Net Loss of Revenue During Modification	$	3,014,564
Modification Cost	$	14,300,0( )
Increased Operating Costs	$	6,637,015
Opportunity Cost	$	________
TOTAL COST	$	________

Opportunity Cost

The final cost examined in this study was the opportunity cost of keeping an aircraft that might otherwise be replaced. However, due to the continuing demand for the Boeing 747 and the likelihood of its future need, no opportunity cost will be applied.

Here, then are the four costs and the total:

Net Loss of Revenue During Modification	$	3,014,564
Modification Cost	$	14,300,000
Increased Operating Costs	$	6,637,015
Opportunity Cost	$	0
TOTAL COST	$	23,951,579

Summary

This chapter has applied the revenue and cost data to the methodologies presented in Chapter III. The final result, $23,951,579, is the sum of each cost, and is the amount that would reimburse the airlines for the conversion, while neither hindering nor advancing their competitive position.

The next chapter will analyze the assumptions used in calculating these costs.

CHAPTER V

ANALYSIS OF RESULTS

Many assumptions were made in arriving at the final result of $23,951,579. This chapter will address those assumptions and their impact on the total cost. The assumptions corresponding to each of the four costs will be examined in the same order that the costs were introduced.

Net Loss of Revenue During Modification

The revenue lost during the eight week modification period was determined using 1982 revenue from all five airlines operating Boeing 747s. This total revenue was divided by the number of Boeing 747 aircraft, then multiplied by 8/52 (for the eight week period), and finally multiplied by 75%. Deducted from this amount were the costs no longer incurred, arriving at the net loss of revenue. These calculations were based on various assumptions, each of which affected the final result.

The first assumption was that a data base of 1982 revenue accurately reflects the revenue that will be earned in 1983 or 1984. Given the erratic nature of airline revenue in the past three years, this assumption may be invalid. And if revenue otherwise earned during the modification

period differs from the 1982 baseline, the amount of revenue lost for two months will also differ.

In addition to using 1982 data, an eight week proportion was used (8/52), with the assumption that the revenue produced throughout the year is uniform. In fact, revenue varies throughout the year, and summer months drawing more revenue than other seasons (see Table 5.1 (56:xxxci)).

Table 5.1

Variability of Demand for Air Travel, by Month

Month	Traffic as Percent of Peak Month
Januray	86
February	66
March	86
April	95
May	93
June	99
July	95
August	100
September	83
October	87
November	79
December	94

The season chosen for modification will therefore affect the revenue lost. Modifying an aircraft in the summer during peak travel will create a greater loss of revenue than in other seasons.

The revenue used in the calculation is also based on an average revenue per aircraft. The actual revenue earned per aircraft will vary among the five airlines, and each would be expected to lose a different amount during the

modification.

The final assumption made in determining the net loss of revenue is the use of a 75 percent revenue loss rate. It is impossible to predict exactly how much revenue will be lost. Customer reaction to a change in schedule and the airline's ability to reschedule their aircraft are highly variable. Consequently, the actual revenue lost could be significantly different.

Modification Cost

The modification cost of $14,300,000 is only an estimate. The actual cost will be determined after all bids for the modification are received and a contract signed.

Increased Operating Costs

Three costs will increase during the modified aircraft's operation: fuel, engine maintenance, and insurance. The increasing price of fuel over the next 16 years is accounted for in the RFP by annual updates to the account. But increasing cost differentials over the 16 year life for engine maintenance and insurance are not reimbursed later; the initial lump sum payment is the only reimbursement for these two costs. This study assumed that the cost differential for engine maintenance would increase 2 percent each year, but that insurance cost differentials would remain the same. Either of these assumptions could in fact

change significantly over the next 16 years.

Also, the discount rate of 8 percent may be an invalid estimate of the rate of return an airline may expect. Airline profits change erratically over time and estimating the average return for the next 16 years is very tentative. Figure 5.1 shows the rate of return on investments for U.S. major airlines from 1971 to 1981.

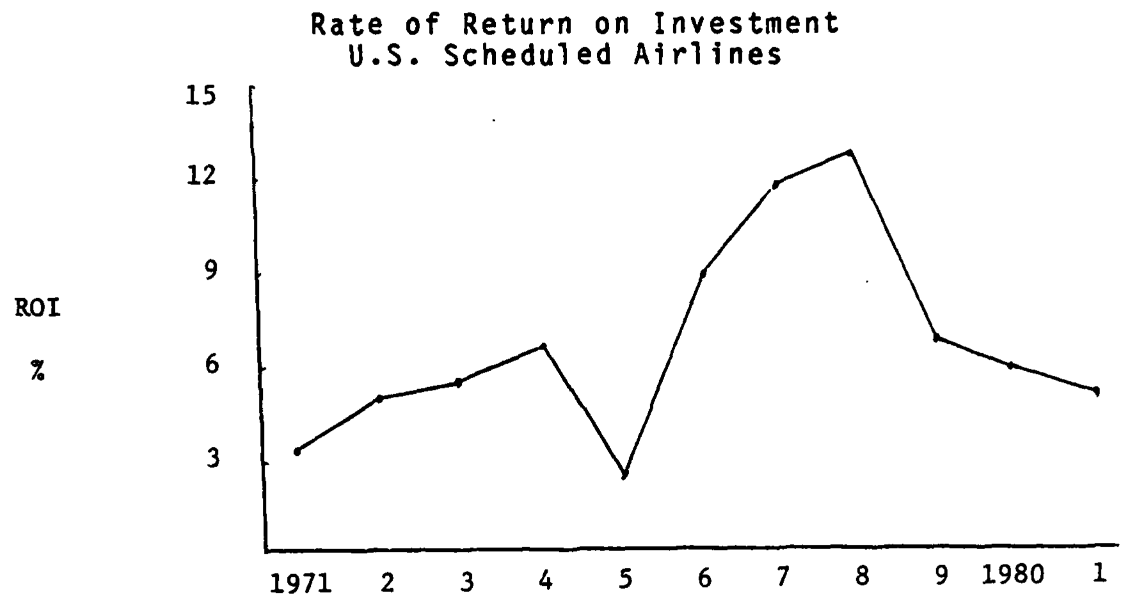

Figure 5.1
Source: Air Transport Association 1982 Annual Report

As indicated, airline rate of returns are highly variable. The average rate of return on investment over the 1971 to 1981 period was 6.58. The RFP's discount rate of 8 percent exceeds this figure, and will be unfavorable for the airlines if their future return on investments remain below 8 percent: increased operating costs will be discounted at a rate greater than what the airlines can earn on their

investments.

Opportunity Cost

The final assumption is that there is no opportunity cost of operating a Boeing 747 convertible. There may, however, be such a cost. Numerous unpredictable factors may change the value of a convertible aircraft, or its revenue producing capability. For example, an aircraft accident involving a Boeing 747 convertible may negatively impact customer preference for the aircraft, or unforeseen marketing events may create a significant opportunity cost of retaining an aircraft that would otherwise be replaced. Assuming a zero opportunity cost may be very speculative for a period as long as 16 years.

Summary

Each of the four costs required assumptions in their determination. These assumptions may prove to be valid, and the final cost may accurately represent the true costs incurred by an airline for converting its aircraft. The assumptions may also be invalid, and the Air Force or the airlines will have made an inequitable exchange. In either case, assumptions must be made which most accurately reflect the information available. Hopefully, neither party will lose, and the United States will win an increase in its force projection capability.

CHAPTER VI

SUMMARY AND RECOMMENDATION

Summary

Soviet expansionism and America's increasing reliance upon imported resources have placed greater emphasis on the United State's ability to project its forces. One proposal for increasing our airlift capability by 5 million-ton-miles per day is the Civil Reserve Air Fleet Enhancement Program, contracting various airlines to modify wide-bodied passenger aircraft for use as convertible aircraft capable of carrying military cargo in time of war. This study traced the civil/military development of airlift that led to the CRAF Enhancement Plan, showed the need for increased airlift capability, and determined the cost of converting one Boeing 747. The final cost of $23,951,579 included the revenue lost during an eight week modification period, the modification cost, and increased operating costs. Opportunity costs were determined to be insignificant.

The single lump sum payment of $23,951,579 per Boeing 747 convertible is substantially less than the cost of acquiring, operating, and maintaining additional military aircraft. The CRAF Enhancement Program thus adds to America's airlift capability at a relatively low ice, and

allows the airlines to improve our civil/military partnership without incurring additional costs.

Recommendation

The RFP invites bids for the conversion of DC-10 aircraft as well as Boeing 747s. Although the DC-10 has 30 percent less payload than the Boeing 747, it can carry oversize military equipment and assist in improving our airlift capability. A similar study should be conducted to determine DC-10 conversion costs.

SELECTED BIBLIOGRAPHY

A. REFERENCES CITED

1. American Airlines, Inc. 1982 Annual Report. Dallas TX, 1982.

2. Annesser, James W. "National Air Transportation System: Analysis of Defense Community Airlift Policy and Requirements." Unpublished doctoral dissertation, University of Miami FL, May 1982.

3. Blaker, James and Andrew Hamilton. Assessing the NATO/Warsaw Pact Military Balance. Washington: Government Printing Office, 1977.

4. Branstetter, Rod. Insurance Consultant, Air Transport Association, Washington DC. Telephone interview. 11 August 1983.

5. Bureau of Mines. Mineral Commodity Summaries, 1980.

6. Burshnick, Anthony J., and Markwell A. Fletcher. "History of Strategic Airlift." Unpublished research report number AD-B011, 384L, Air War College, Maxwell AFB AL, 1976.

7. Cleveland, Reginald M. Air Transport at War. New York: Harper & Brothers, 1946.

8. Congressional Record, March 19, 1937.

9. Craven, Wesley F., and James L. Cate, eds. Services Around the World (The Army Air Forces in World War II). Chicago: The University of Chicago Press, 1946.

10. Daniel, Lieutenant Colonel Marshall E., Jr. Defense Transportation Organization: Strategic Mobility in Changing Times. Washington: Government Printing Office, 1979.

11. Directorate of Plans, Headquarters Military Airlift Command. Scott AFB IL, 1983.

12. Frederick, John H. Commercial Air Transportation. Homewood IL: Richard D. Irwin, 1958.

13. Gauvreau, Emile, and Lester Cohen. Billy Mitchell. New York: E. P. Dutton, 1942.

14. Glass, Gerald. Labor Relations Department, Air Transport Association, Washington DC. Telephone interview. 14 June 1983.

15. Gropman, Colonel Alan L., USAF. "The Compelling Requirement for Combat Airlift," Air University Review, July-August 1982, pp. 2-15.

16. Harrington, Major Thomas C., USAF. "The Defense Transportation System: Giving Direction to Change." Unpublished Research Report, 8-81, AFIT/LS, Wright-Patterson AFB OH, December 1982.

17. Historical Services and Research Division, Directorate of Information, Headquarters Military Airlift Command. History, Military Airlift Command, 1 July 1965-30 June 1966, Vol. 1. March 1967.

18. Levine, Isaac Don. Mitchell, Pioneer of Air Power. Cleveland and New York: World Publishing Company, 1943.

19. Lissitzyn, Oliver James. International Air Transport and National Policy. New York: Council on Foreign Relations, 1942.

20. MAC Contracting Office, HQ MAC. CRAF Enhancement Program RFP #F11626-83-R-0024. Part C., Sec. 1. Scott AFB IL, March 1983.

21. Mathis, General Robert C., USAF. "Defense Myths--and Facts," Air Force Magazine, June 1982, pp. 15-17.

22. "Military Airlift Command," Air Force Magazine, May 1982, pp.95-98.

23. Military Airlift Command. MAC Master Airlift Plan, Vol. I, "Inter- and Intratheater Airlift." Scott AFB IL, 1983.

24. Mitchell, William. Winged Defense. New York and London: G. P. Putnam's Sons, 1925.

25. Morrow Board. U.S. Report of the President's Aircraft Board. Washington: Government Printing Office, 1925.

26. Mosemann, Lloyd K. II. "The Air Force's Solution to the Airlift Shortfall," Defense Management Journal, Second Quarter 1983, pp. 20-23.

27. Newhouse, John. The Sporty Game. New York: Alfred A. Knopf, Inc., 1982.

28. Northwest Orient Airlines, Inc. 1982 Annual Report. Minneapolis MN, 1982.

29. Office of Civil Air, Military Airlift Command. Monthly Civil Reserve Air Fleet Capabilities Summary Sheet. Scott AFB IL, 1 April 1983.

30. Orr, Verne, Secretary of the Air Force. "Facing Two Critical Challenges," Air Force Magazine, May 1982, pp. 74-78.

31. Pan American World Airways, Inc. 1982 Annual Report. New York, 1982.

32. President's Aircraft Board. U.S. Report of the President's Aircraft Board. Washington: Government Printing Office, 1925.

33. Roser, Major Steven, USAF. Office of Civil Air, HQ MAC,Scott AFB IL. Personal Interview. 19 April 1983.

34. Sable, Ronald K. "Civil Reserve Air Fleet (CRAF): A Primer for Defense and Industry." Unpublished research report No. MSO 25-79, Air War College, Maxwell AFB AL, 1979.

35. Senate Congressional Aviation Policy Board, U.S. Congress. National Aviation Policy. Washington: Government Printing Office, 1948.

36. Skousen, Fred K., Harold Q. Longenderfer, and W. Steve Albrecht. Principals of Accounting. New York: Worth Publishing Co., 1981.

37. Smith, Henry L. Airways: The History of Commercial Aviation in the United States. New York: Alfred A. Knopf, 1942.

38. Spencer, Francis A. Airmail Payment and the Government. Washington: Brookings Institution, 1941.

39. Spencer, Frank. A Reappraisal of Transport Aircraft Needs, 1985-2000. Northwest University: NW University Press, 1982.

40. Steery, John P. Maintenance Analyst, Boeing Aircraft Co., Seattle WA. Telephone interview. 26 July 1983.

41. Steiner, Robert. Cost Accounting Department, Boeing Aircraft Co., Seattle WA. Telephone interview. 2 July 1983.

42. Thayer, Frederick C., Jr. Air Transportation Policy and National Security. Chapel Hill NC: University of North Carolina Press, 1965.

43. Transworld Corporation. 1982 Annual Report. Kansas City, 1982.

44. United Airlines, Inc. 1982 Annual Report. Denver, 1982.

45. U.S. Civil Aeronautics Board. Air Carrier Traffic Statistics. Washington: Government Printing Office, 1982.

46. ________. Uniform System of Accounts and Reports (CAB Form 41 Schedules). Washington: Government Printing Office, 1982.

47. U.S. Congress. Civil Aeronautics Act of 1938. Sec. Z(a), 52 Stat. 980. Washington: Government Printing Office, 1938.

48. ________. Senate Congressional Aviation Policy Board, National Aviation Policy. Senate Report NO. 1949. Washington: Government Printing Office, 1948.

49. U.S. Department of the Air Force. Air Force Report FY 1984. Washington: Government Printing Office, 1983.

50. U.S. Department of Transportation, Federal Aviation Agency. FAA Aviation Forecast, FY 1983-1994. U.S. DOT Report #FAA-APO-83-1, Washington, D.C., February 1983.

51. ________. U.S. Department of Transportation, Federal Aviation Agency. Federal Aviation Regulation, Part 121. Washington: Government Printing Office, 1981.

52. U.S Joint Chiefs of Staff. United States Military Posture for FY 1984. Washington: Government Printing Office, 1983.

53. U.S. President's Air Policy Commission. Survival In The Air Age. Washington: Government Printing Office, 1948.

54. Weinberger, Caspar W., Secretary of Defense. Address to the American Newspaper Publishers Association, Chicago, 5 July 1981.

55. __________. "Requirements of Our National Defense," Military Affairs, July 1981, pp.46-48.

56. World Aviation Directory. New York: Ziff-Davis Pulbishing Co., 1982.

57. Wyckoff, D. Daryl and David H. Maister. The Domestic Airline Industry. Lexington MA: D.C. Heath & Co., 1977.

58. Zav'yalov, General-Lieutenant I.G., U.S.S.R. "The New Weapon and Military Art," Red Star (Moscow), 30 October 1970, pp. 2-3.

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